The Potential for Biomass-based Electric Generation in Indiana

Summary

- Biomass has become front page news in Indiana. Farmers throughout the state are rapidly considering how to transform their corn and soybean crops into profitable sources of energy.
- The purpose of this brief is to focus on *biopower*, more formally called "biomass-based electric generation." Biopower refers to technologies that convert biomass (e.g. crop waste, manure, and saw dust) into electricity. (See appendices for biomass resources and conversion technologies)
- In Indiana, biomass resources for biopower consist of landfill and digester gases, forest and mill residues, urban (yard/ right-of way trimmings and construction) wastes, agricultural residues, as well as dedicated energy crops, such as switchgrass.[13]
- In 2002, only 0.1% of Indiana's total electric generation came from biomass sources.[2]
- As of December 31, 2005, Michigan had 419 MW of installed biomass generating capacity, Minnesota had 267 MW, Wisconsin had 207 MW, Illinois had 58 MW, and Indiana had only 6 MW of installed biomass generating capacity.[14]
- Approximately, 27.1 thousand GWh of electricity could be generated using biomass fuels in Indiana. This is enough to supply all of the state's residential demand.[15]
- Biomass resources are available throughout the state. Wood, mill, and urban wood residues, as well as methane emissions from landfills and promising lands for energy crops are particularly concentrated in areas of Indiana which have less wind resources.[16]

Indiana's Biomass Resources: A Closer Look

Ball State University (in Muncie) has undertaken a study looking into potential switchgrass production on marginal lands (defined as: highly erodible lands (HEL) Conservation Reserve Program (CRP) lands, and reclaimed surface mine lands) in Indiana. Delaware and Owen Counties were selected as case studies with Lafayette and Martinsville respectively representing the urban centers in which electricity would be produced. The switchgrass yields on HEL and CRP lands in Delaware County were 203,000 tons/yr (3,246,000 MBtu/yr). The Owen County yields were 232,950 tons/yr (3,731,200 MBtu/yr). This combined total is enough electricity to meet the needs of over 20,000 Indiana homes and businesses. In addition, it was found that in each of these counties 5-10% biomass co-firing with coal would be possible utililizing only 5-10% of agricultural lands within an economically feasible transportation distance (30 miles) of the generation plant. (See appendix four for county and switchgrass potential maps.)[5]

- [1] In 2004, there were no biodiesel plants and only one ethanol plant in Indiana. By 2006, three biodiesel plants and twenty-four ethanol plants are operating, under construction, or planned.[13] In fact, Indiana will soon be home to the largest soybiodiesel facility in the world. "StateSpotlight:Indiana" http://www.e85fuel.com. March 2005.
- This type of energy generation is called *biofuels* and is used largely in the transportation sector. Indiana's booming biofuel industry illustrates continued demand for biomass resources as well as the state's commitment to utilizing its ample biomass resources.

[2] "2005 Indiana Renewable Energy Resources Guide" State Utility Forecasting Group. Purdue University. 2005

[3] "Fuel Freedom" www.lugar2006.com2006.

[4] "Fuels of the Future" indystar.com. August 27, 2006.

[5] Brown et al. "Biomass: Connecting Biomass Producers with Users: Biomass Production on Marginal Lands." November 13, 2002

Biopower Technologies for Indiana

- Municipal solid waste (MSW) and landfill gas are the most common biomass fuel for electricity generation in Indiana.[2]
- Switchgrass, with a heating value of 18.3 Gigajoules/ton, has been identified as the most effective energy crop for Indiana, as it is native to the area, does not require much input after planting (less chance of soil erosion), is harvested prior to corn and soybeans, and requires the same equipment.[2]
- Biopower technologies of the future include gasification and biomass co-firing.

Prominent Biomass Projects in Indiana*

- As of July 2006 there were 17 operational landfill gas projects, and 16 candidates for new projects.[6]
- As of winter 2006, there were also two manure-to-biogas digester projects with a combined capacity of 3,504 MWh/yr in operation and another two planned to bring the total manure-to-biogas generating capacity to nearly 5,000 MWh/yr.[7]

Investor Owned Utilities

- Duke Energy of Indiana has commissioned feasibility reports for anaerobic digester gas projects in 2002 and 2003, reviewed the technical and economic viability of co-firing with biomass in 2004, and is currently supporting a feasibility study to co-fire switchgrass with coal at Purdue's Wade facility, which uses circulating fluidized bed coal technology.[8]

Rural Electric Cooperatives

- Wabash Valley Power's biomass projects consist of 7 landfill gas plants, totaling 22.4 MW.[9]
- Hoosier Energy intends to bring two more megawatts of landfill gas generated electricity online in late 2007 with another two or three megawatts to follow shortly after that. The cooperative is also considering the use of anaerobic digesters on commercial farms.[10]

Government-Sponsored Projects

- BioTown, USA, formerly known as Reynolds, IN has become the foremost model of how a community can provide for 100% of its energy needs using local renewable energy. While transportation fuels will include both E85 and biodiesel, electricity will be generated through an anaerobic digester, a gasifier and fast pyrolysis (low to no oxygen burn). Ground breaking for the biomass power plant is slated for November of 2006.[11]

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* Approximately 40% of Indiana's utilities offer a Green Pricing Program. These programs can be very effective. For example, Wisconsin's largest utility promotes its Energy for Tomorrow (EFT) green pricing program, which provides customers with the option of purchasing 25, 50, or 100 percent of their electricity as renewable energy at a premium of $0.0137/kWh (at the 100% level). In 2005, more than 12,000 customers subscribed to the EFT program, purchasing over 50,000 megawatt hours of renewable energy. http://www.we-energies.com/residential/acctoptions/eft.htm

[6] "Status of LFGE Project Development and Candidate Landfills by State" Landfill Methane Outreach Program. 2006

[7] "AgSTAR Digesters Continue Accelerating in the U.S. Livestock Market". www.epa.gov/agstar/pdf/2006digest.pdf. winter 2006)

[8] Personal correspondence with Duke Energy Representative. September 24, 2006

[9] Wabash Valley Power Association. http://www.wvpa.com/our_powerplants.aspx. 2006.

[10] Personal correspondences with Hoosier Energy Representative. September 29, 2006

[11] "BioTown,USA" http://www.in.gov/biotownusa/news.htm.2006.

Private Biomass Projects

- Using cow manure as a feedstock, the Fair Oaks Dairy in northwest Indiana (Jasper and Newton Counties), had an estimated generating capacity of over 2150 kW in 2005 Fair Oaks is comprised of four family farms, which have each installed biogas digesters (manufactured by GHD, Inc. Chilton, WI), producing 60% methane biogas. The biogas is used for heat and electricity on the farms. Since methane is a powerful greenhouse gas, the farm was able to sign an agreement with Environmental Credit Corp (ECC) to create more than one million carbon credits. Carbon credits have nearly doubled in value to approximately $4.00 per ton since 2005. The greenhouse gas reductions at the farm can be compared to the planting of 4 million trees.[12]

Biopower on the Cutting Edge: Examples from Indiana and Other States

- The Northern Indiana Public Service Company (NIPSCO) conducted urban wood waste biomass cofiring tests at two of its coal-fired power plants. The tests used biomass input fuel mix of 6.5 percent and 5 percent, respectively, and both burns reduced emissions of nitrogen oxides, sulfur dioxide and carbon dioxide.[2]
- NIPSCO is presently seeking regulatory approval to replace coal with biomass in about 500 MWs of generation. The anticipated three percent biomass blend would reduce carbon emissions by approximately 80,000 tons per year.[13]
- NIPSCO has also been involved in a biomass gasification project in which the biomass producer gas is fired downstream of the combustion turbine to improve heat recovery efficiencies.[14]
- The Chariton Valley Project at Ottumwa Station, Iowa completed a one-month cofiring test burn of switchgrass with coal in 2003. The success of this test led to the nearly 1,700 hour test burn that occurred during the spring of 2006. Over 15,600 tons of Iowa's locally grown switchgrass and other native grasses were burned, displacing 12,000 tons of coal and producing over 19,600 megawatt-hours. This represents a 51,000 ton carbon dioxide emission reduction. On May 12, 2006 the test burn was completed. Further analysis is underway, and commercialization may occur in the near future. [17]
- Anaerobic digestion can destroy up to 70% of Volatile Organic Solids (VSS), which make up nearly 70% of wastewater sludge. Considering that one lb of VSS destroyed produces approximately 1 kWh, wastewater is a valuable energy feedstock. Two Michigan wastewater treatment plants (WWTP) will be adding anaerobic digesters with the capacity to treat 4 and 20 million gallons of wastewater. The plants will produce 60-70 kW and approximately 800 kW of energy respectively. Existing Michigan digesters are destroying about 36,312,000 lbs/yr of volatile organic solids. Therefore, a constant 4.145 MWh is being

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[12] "Indiana Dairies to Capture More than a Million Tons of Greenhouse Gases. "
http:www.ruralenergy.co.nz/blog2/archives/cat_biogas.html . June 13, 2006
(Combined Heat and Power Database http://www.eea-inc.com/chpdata/States/IN.html)
[13]"Carbon Disclosure Project (CDP4) Greenhouse Gas Emissions Questionnaire". www.nisource.com. 2005
[14] "Cofiring Biomass in Coal-Fired Boilers: Results of Utility Demonstrations." Foster Wheeler Review 1999.
[15] "Record Setting Switchgrass Testing Comes to Successful End"
http://www.alliantenergy.com/docs/groups/public/documents/pub/p015315.hcsp. May 25, 2006

produced. By adding digesters at other WWTP, Michigan could be producing 30.210 MW at their WWTP alone.[16, *]

- The city of West Lafayette, IN is investing $9.4 million to upgrade its digesters at its WWTP and to install a grease receiving station. While the digesters will generate electricity and heat, the fee-based grease processing station will create an extra revenue source to help pay for the project as well as create a centralized source of some of the digester feedstock. M.D. Wessler & Associates of Indianapolis is responsible for much of the project design.[17]

The Cost of Biomass-Generated Electricity

- According to the Department of Energy (DOE),

"A typical existing coal fueled power plant produces power for about 2.3 cents/kWh. Cofiring inexpensive biomass fuels can reduce this cost to 2.1 cents/kWh. In today's direct-fired biomass power plants, generation costs are about 9 cents/kWh. In the future, advanced technologies such as gasification based systems could generate power for as little as 5 cents/kWh. For comparison, a new combined-cycle power plant using natural gas can generate electricity for about 4 to 5 cents/kWh at today's gas prices."[2]

- Corn stover (stalks and leaves) alone, can generate approximately $130/acre of additional income for Indiana farmers.[18]

Incentives for Biomass Projects*

- The Indiana Biomass Grant Program offers up to $20,000 to be used towards research, development, and production of biomass energy systems with the intention of increasing the amount of biomass used in Indiana's energy mix. Projects emphasizing collaboration amongst local and regional organizations, researchers, industries, utilities and government are given priority.[19]
- Wisconsin's Focus on Energy Program offers up to $75,000 for projects using anaerobic digesters or non-residential wood and wood-waste burning. The maximum amount allocated is based on the amount of electricity and/or the amount of thermal energy that the biogas digester or non-residential wood system will produce in one year. The grant excludes landfill gas and corn as feedstocks.
- Iowa's Methane Gas Conversion Property Tax Exemption allows sanitary landfills a tax exemption equal to the percentage of methane used as a fuel source in generating energy.[21]

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*Even Grand Rapids' Zoo is converting manure and wastewater to biogas. http://www.michigan.gov/cis/0,1607,7-154-10573_11472-144985--M_1998_7,00.html

*Indiana's Alternative Power and Energy Program offered grants of up to $250,000 projects that generate electricity and/or thermal energy using organic biomass conversion (including agricultural waste, woody biomass, municipal sewage and food-process waste; landfill gas, waste-to-energy processes using fluidized bed, and fast pyrolysis technologies were included. The deadline for applications was September 1, 2006. A new request for proposals has not yet been issued. http://www.in.gov/energy/programs/current.html

* Wisconsin's Biobased Industry Opportunity grant program awarded $1,000,000 in 2006 150,000. Included in the awardees were: a continual process pyrolysis unit of commercial scale, two biobased natural gas replacement systems, and a feasibility study of a digester to utilize spent distiller grains. http://power.wisconsin.gov/biogrants.html

[16] "Biomass Inventory: Wastewater Treatment Plant Energy Renewable Energy Workgroup" Greg Mulder, G. and Simpkins, D. http://www.michigan.gov/cis/0,1607,7-154-10573_11472-144985--M_1998_7,00.html

[17] "West Lafayette Wastewater Treatment Renovation to Save Energy, Costs, and Generate Revenues" July 5, 2006 www.city.west-lafayette.in.us [18] "Hoosier Homegrown Energy: Indiana's Strategic Energy Plan."

[18] "Hoosier Homegrown Energy: Indiana's Strategic Energy Plan" www.in.gov. 2006

[19] http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterFundingStatesIN.html 2006

[20] "Implementation Grant." Focus on Energy Renewable Energy Program. valid through June 30, 2007

[21] http://www.dsireusa.org 2006

Appendix 1: What are different kinds of biomass resources?

Summary

Bioenergy constituted 4 percent of the total energy and 47 percent of the total renewable energy consumed in the US in 2003. Recently surpassing hydropower, it has become the nation's largest renewable energy source. While the use of biomass energy is common, there is significant untapped potential throughout the US and in Indiana particularly. [1]

Biomass resources

Biopower feedstocks include urban waste, mill residues, forest residues, agricultural residues and dedicated energy crops. The moisture content, processing requirements, transportation distance, and uniformity of fuel determine the efficiency and thus the ability of each resource to compete with conventional fuels. [2]

Agriculture crop residues are comprised primarily of stalks and leaves, not harvested or removed from the fields in commercial use [1].

Forestry residues include biomass not harvested or removed from logging sites in commercial stands as well as material resulting from forest management operations, such as pre-commercial thinnings and removal of dead and dying trees [1].

Municipal solid waste (MSW): Residential, commercial, and institutional post consumer wastes contain a significant proportion of plant derived organic material that constitutes a renewable energy resource [1].

Biomass processing residues: Processing of biomass yields byproducts and wastes called residues. Residues, which have significant energy potential, are simple to use because they have already been collected (processing of wood for products or pulp produces sawdust and collection of bark, branches and leaves/needles) [1].

Animal wastes constitute a complex source of organic materials with environmental consequences. These wastes can be used to make many products, including energy [1].

Dedicated Energy Crops are perennial grasses and trees produced with traditional agricultural practices for the purpose of electricity production [1].

Biopower Technologies

Close to 3,000 biomass power plants currently operate in the US. Plant capacities range from 20 megawatts (MW) to 50 MW in contrast to the several hundred MW capacities of fossil fuel plants [2].

Appendix 2: What are Different Kinds of Biopower Technologies?

Biomass direct combustion converts biomass to heat energy, which in turn produces electricity through a steam turbine system. In general, direct-fired biopower plants generate electricity at approximately 6.4 cents per kilowatt-hour (kWh) to 11.3 cents per kWh. Capital costs for biopower plants are in the range of $2,000 per kW. [2]

Biomass co-firing involves mixing (5-10%) biomass with fossil fuels. Modifications to a coal plant can have payback periods of 2-3 years. Cost estimates for these modifications are approximately $180 per kW to $200 per kW depending on the plant's capacity [2].

Biomass gasification is a thermo-chemical process which converts approximately 65-70 percent of available energy from biomass into gases to be used to generate heat or electricity [1]. Cleaning and conditioning of resultant gases is required before use. In a cogeneration application biogas efficiencies could reach 80 percent [2].

Anaerobic Digesters use bacteria to convert manure into gas to generate electricity or heat. Digesters also control odors and make use of methane, a potent greenhouse gases. The technology is commonly used at wastewater treatment plants and by the food processing industry. [2]

Landfill Gas Systems: Most landfills equipped to capture emissions generate electricity for sale. Plant capacity generally ranges from 1 MW to 5 MW, with power generated for $0.05 / kWh and $0.10 / kWh. Most landfill gas systems utilize the internal combustion engine and emit varying proportions of carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO2), hydrogen chloride and particulate matter, depending on landfill composition. Gas collection systems are typically 60 percent to 85 percent efficient. [2] All of these technologies display greater economic competitiveness with increased capacity. Typical efficiency ranges are from 20 to 24 percent for direct combustion, 33 to 35 percent for biomass cofiring and 35 to 45 percent for gasification [1].

Biorefineries: much like petroleum refineries can maximize the value derived from feedstock by producing multiple products. High-value products increase profitability, while high-volume fuel helps meet national energy needs, and power production reduces costs and avoids greenhouse gas emissions. Several large chemical companies have announced commitments to biorefineries, and the DOE announced $160 million in support for construction of three new biorefineries.

Pyrolysis: uses no to low oxygen burning to break down liquid or dry biomass to produce heat and bio-oils at low temperatures.

Appendix 3: What are policy options to advocate biopower?

Renewable Portfolio Standards (RPS) is a flexible mandate that requires utilities to build or buy a certain amount of renewable energy capacity each year. Some states require that a certain percentage of the RPS be met by one resource or technology, while the remaining percentage is met by others. [2]

Public Benefit Fund is typically a state-level program designed to ensure continued support of renewable energy, energy efficiency and low income energy assistance

projects. The funds are supported through a charge that all customers pay based on their electricity consumption, e.g., 0.2 cents/kWh. Funds have been used to buy-down the per kWh cost of renewable energy; to provide rebates on renewable energy systems; to fund renewable energy R&D and education programs. [2]

Interconnection: As defined by the Interstate Renewable Energy Council, interconnection standards consist of the technical, contractual, rates and metering issues that must be settled between a system owner and the utility and local permitting authorities before a system is connected to the grid. The technical specifications and contractual obligations often vary by utility. Unfortunately, large interconnection fees are often associated with hindering investment. Furthermore, product standardization becomes impractical, keeping technology costs artificially high. [2]

Net metering allows customer-generators to feed excess electricity into the power grid when they generate more power than they need and to draw power from the grid when they generate less power than they need. Most states limit either the size, number, or capacity of net metered systems, which often limits participation of small-scale biopower systems, too large to qualify for net metering programs. [2]

Green Pricing allows participating utility customers to support renewable energy by paying a fee on their electric bill to cover the cost of additional renewable energy. In 2005, more than 12,000 customers subscribed to Wisconsin's EFT program and purchased more than 50,000 MW. 14 Indiana utilities offer green pricing. [2]

Renewable Energy Credits (RECs)/ Emissions Credits: are certificates of the environmental, economic and social attributes of a given quantity of renewable generation. The certificate can be retired or sold to consumers, marketers, or to companies that need to comply with voluntary or mandatory renewable energy targets. In most states with an RPS, RECs are required or may be used to demonstrate compliance with the mandate [2]. There are several regionally based programs devoted to monitoring and tracking RECs and/or certifying green energy which meets specified environmental and consumer protection standards. Utility participation in these programs is generally voluntary, but may be mandatory [1].

Income Tax Credit: Several states offer personal income tax credits or deductions to cover the expense of purchasing or installing renewable energy equipment. The allowable credit may be limited to a percentage or dollar amount for the cost or installation of renewable energy equipment or to a certain number of years following the purchase. [2]

Investment Tax Credit: The investment tax credit provides a credit against income taxes, usually computed as a percent in the cost of investment in certain assets [2].

Production Tax Credit: The production incentive provides owners of biopower facilities with cash payments based on electricity production on dollars per kWh. Payments based on performance rather than on capital investments often can be more effective [2]. A tax credit of 1.9 cents/kWh for closed-loop for 10 years, open-loop biomass and municipal solid waste resources will receive half that rate for five years [1].
Property Tax Credit: Property tax incentives typically follow one of three basic structures: exemptions, exclusions or credits. The majority of the property tax provisions for renewable energy follow a simple model that provides the added value of the renewable device not be included in the valuation of the property for taxation purposes.

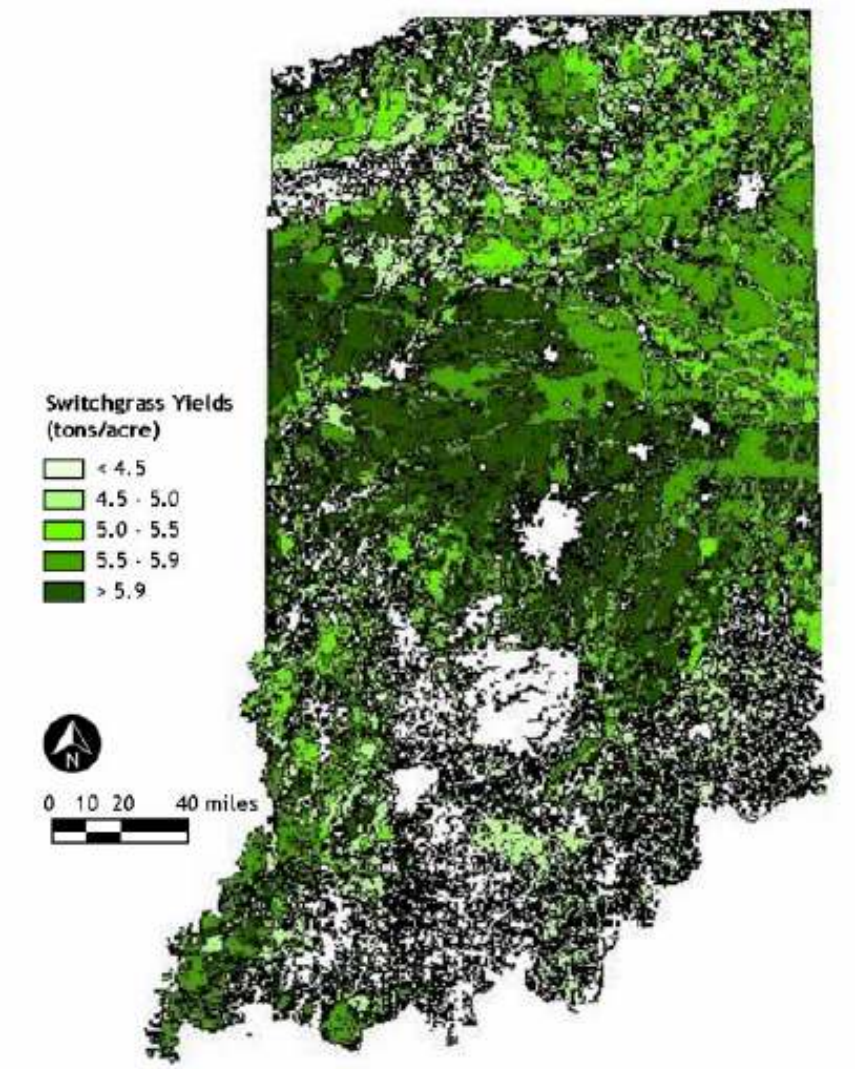
Property taxes are collected locally, so some states allow the local authorities the option of providing a property tax incentive for renewable energy devices and infrastructure. [2]

Sales Tax Credit: Sales tax incentives typically exempt the cost of renewable energy equipment from the state sales tax [2]

Grant and Loan Programs: States offer a variety of grant programs to the commercial, industrial, utility, education and government sectors, to encourage both the use and development of renewable energy technologies. Grant programs may focus on education, R&D, or helping a specific project achieve commercialization. Amounts offered range from $500 to $1 million. Some states do not set a limit. State governments also offer loans to assist in the purchase of renewable energy equipment. [2]

Energy Efficiency and Renewable Energy (EERE) Set-Aside is a joint effort of the Indiana Energy and Recycling Office (ERO) and the Indiana Office of Air Quality (OAQ) that offers potential financial incentives to large-scale energy-efficiency projects and renewable-energy projects that significantly reduce nitrogen-oxide (NOx) emissions [1].

Appendix 4: Indiana's Switchgrass Potential



(Source: Brown et al. 2002)

(Source: www.dearborncounty.org/maps.html)

Appendices References:

1. 2005 Indiana Renewable Energy Resources Guide. State Utility Forecasting Group. Purdue University. 2005
2. Bioenergy: Power, Fuels, and Products. National Conference of State Legislatures. 2006.
3. "Biomass: Connecting Biomass Producers with Users: Biomass Production on Marginal Lands in Indiana"Brown et al. 2002.
4. www.dearborncounty.org/maps.html)